Sonochemically synthesized ZnO nanosheets and nanorods: Annealing temperature effects on the structure, and optical properties

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Abstract:

ZnO nanopowders were successfully synthesized by the ice-bath assisted sonochemical method. The nanopowders were annealed in air for 3 h at different annealing temperatures (Ta) ranging from 300 to 700 °C. The effect of Ta on the structural and morphological properties was investigated by the x-ray diffraction (XRD) and the transmission electron microscopy (TEM). The optical properties were studied by recording the optical absorption and photoluminescence (PL) spectra. The XRD analysis showed that the thermal annealing leads to an improvement in the crystallinity associated with an increase in the crystallite size as well as an increase in both the Zn-O bond length and unit cell volume. Also, it was found that the increase of Ta results in a shift in the diffraction angle toward lower values associated with a decrease in the micro-strain. The morphological study confirms that the samples are mixtures of nanosheets and nanorods. In addition, the length and diameter of the nanorods increase as the annealing temperature increases. The optical absorption spectra show that the exciton peak of the as-prepared sample is red shifted from 370 to 378 nm by thermal annealing, and the optical band gap decreases from 3.45 to 3.36 eV. The photoluminescence spectra were reordered at an excitation wavelength of 325 nm, and the deconvolution of the spectra reveals four emission bands where the main UV band (at λ=397 nm) can be attributed to exciton recombination related to near-band-edge. Furthermore, the thermal annealing results in a reduction of the PL intensity of the annealed samples.

Keywords:

ZnO nanostructures; Sonochemical preparation; Thermal annealing; Optical properties; Photoluminescence

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